

Australia is a desert animal and its former presence in southern localities may be evidence of a more arid climatic interval at that time. Cook (1960: 108) has already offered this explanation to account for the presence of remains of the Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and the Dalgite (*Macrotis lagotis*) in certain of the South-West caves. Some of the distribution maps given by Lundelius (1957) would suggest the same thing, namely that creatures (such as *Dasyercus* and *Sminthopsis hirtipes*) now found living only in distant desert areas once inhabited localities in what is now more humid country towards the South-West corner.

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## THE FLORA OF THE SHOALWATER BAY ISLANDS

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### INTRODUCTION

The Cape (or Point) Peron peninsula is the only portion of a north-south trending ridge of limestone that is now attached (as a tombolo) to the mainland. To the north of Cape Peron supramarine segments of the ridge constitute the present Garden and Carnae Islands, the Mewstone and the Stragglers. South from Cape Peron the ridge extends as a chain of islets and reefs to the southwestern corner of Warnbro' Sound. For geological details of this area see Fairbridge (1950) and Carrigy (1956).

The flora of Garden and Carnae Islands have been listed by McArthur (1957). The flora of the southern islands is described herein for the first time. All the islands forming the western boundary of Shoalwater Bay are vegetated. The rocks and islets stretching south from Penguin Island to the Seven Sisters were scanned from the former with field glasses and appeared devoid of plant-life.

A series of islands, such as Bird, Gull, Seal, Shag and Penguin, which vary in size and number of habitats, illustrates the process of floristic impoverishment in shrinking land masses. The larger islands, Penguin and Seal, with their beaches and dunes support a moderately rich flora. As the islands decrease in area from about three to two acres, especially when their longer axis as in Shag and Bird is east-west, dunes and beaches are swept away with

ensuing loss of several plant species. Further reduction in area results in the extinction of the last remnants of sclerophyllous shrubbery, and the process is complete when such hardy lithophytes as *Carpobrotus* and *Nitraria* disappear.

Another fruitful field is the effect on the vegetation of hordes of nesting and roosting seabirds. This aspect will be dealt with separately by Dr. Mary Gillham who accompanied the writer on the islands in October 1959.

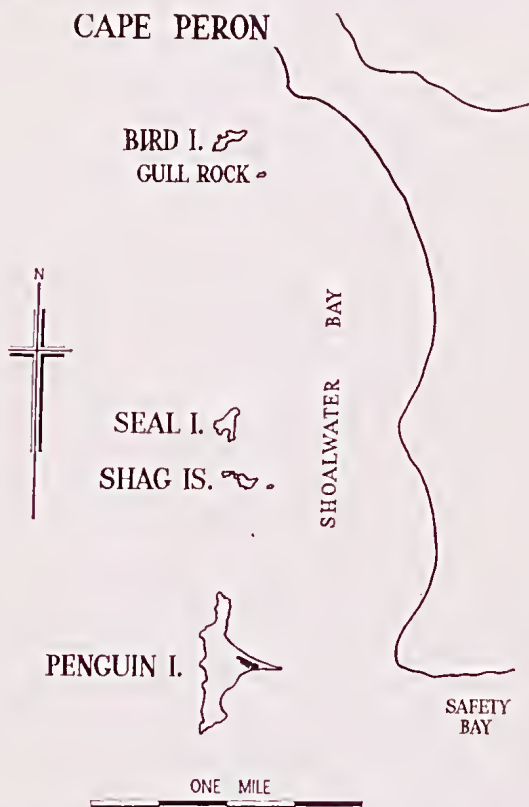


Fig. 1.—Map of islands south of Cape Peron. The extent of the settlement on Penguin Island is indicated by hachuring.

#### BRIEF DESCRIPTION OF THE ISLANDS

Penguin is by far the largest and most varied island in the group. In its orientation, shape and physiography, it is a small replica of Garden Island. The northern and southern headlands are rocky. The centre is covered with dunes whose western slopes are unstable and much of this area is blown out, the freshly exposed sand being reddish as on Garden Island. The steep sheltered eastern slopes of white sand are stable and heavily vegetated. To the east of the dunes a beach has been formed, which extends as a spit towards the mainland.

Shag Island has recently been fragmented into three unequal portions, herein referred to as West, Middle and East Shag. Owing to their east-west trend they lack dunes and beaches. The largest is Middle Shag, the top of which is a plateau gently dipping to the north and thinly covered with soil. Below the plateau on the northern side is a sand serec remarkable for a small but tenacious stand of *Myoporum insulare*. The southern face of the island is largely composed of rock falls interspersed with shelves of sand.

Seal Island consists of three rocky headlands (in the north, southwest and southeast) connected by a sandy saddle, in the lee of which a small beach has formed. Of the smaller islands its physiography is the most varied, as is consequently its vegetation.

Though a little larger and higher, Bird Island is very similar in orientation and physiognomy to Shag Island. Its plateau dips to the north and its western end is in process of being dismembered. Its eastern satellite is similar to East Shag but is further removed and has received a separate name—Gull Rock.

#### ISLAND HABITATS

1. **Honeycombed rock with soil restricted to cracks and depressions.** This comprises the whole of the smallest islands and the windward cliffs of the larger. *Nitraria schoberi* and *Carpobrotus aequilaterus* are usually the only plants present. *Salicornia australis*, *Sporobolus virginicus* and *Wilsonia backhousei* are rare and local in shallow depressions on rock edges drenched with spray.

2. **Talus slope.** Where undereut cliffs fall in sheltered situations there accumulate rock debris of various size together with sand formed locally by weathering of freshly-exposed soft limestone. Characteristic plants: *Nitraria*, *Carpobrotus*, *Enchylaena tomentosa*, *Threlkeldia diffusa*, *Tetragonia implexicoma*, *Calandrinia eulyprata*, *Senecio luteus*, *Bromus spp.*, *Apium australe* and *Solanum nigrum*.

3. **Level or gently sloping rock with a thin mantle of soil.** This is typically represented by the plateau-like tops of the larger islands, and is the principal site of the gull rookeries. Characteristic plants: *Carpobrotus*, *Lavatera plebeia*, *Lepidium foliosum*, *Malva parviflora*, *Hordeum leporinum*, *Melilotus indica*, *Medicago denticulata*, and (where the soil is deeper) *Rhagodia baccata*. Where there are few or no surface-nesting sea-birds, as on Penguin Island, sclerophyllous species may be present, e.g. *Frankenia pauciflora*, *Senecio crassifolia*, *Argemone cunninghamii* and *Scirpus nodosus*.

4. **Foredunes.** Raised beaches occur only on the eastern side of the larger and north-south orientated islands, viz. Penguin and Seal; on the latter their extent is limited. Characteristic plants: *Cakile maritima*, *Arctotheca nivea*, *Tetragonia zeyheri*, *Salsola kali*, *Spinifex longifolius* and *Atriplex cinerea*.

5. **Windward slope of dunes.** Restricted to Penguin Island. Characteristic plants: *Spyridium globulosum*, *Alyxia buxifolia* and *Conostylis candicans*. Blowouts are common and there are extensive areas of bare sand near the central western coast.

6. **Leeward slope of dunes.** The sheltered eastern slopes of the dunes on Penguin Island are covered with *Acacia rostellifera* scrub. The habitat is absent on the other islands except for a slight development in the lee of the southwestern headland of Seal, where however there is no great depth of sand and the prevailing vegetation is a low, dense, wind-pruned thicket of *Pittosporum phillyraeoides*.

TABLE 1.—AREA, APPROXIMATE ALTITUDE AND HABITATS OF EACH ISLAND

island	area (acres)	altitude (feet)	niches present
Penguin	29.4	60	1,2,3,4,5,6
Seal	3.0	30	1,2,3,4,6
Bird	2.2	35	1,2,3
Middle Shag	1.1	30	1,2,3
West Shag	0.4	20	1,2,3
East Shag	0.1	15	1,3
Gull	0.1	10	1

#### ANNOTATED LIST OF PLANTS

Exotic species are prefixed with an asterisk.

##### GRAMINEAE

- \**Stenotaphrum secundatum* (Walt.) O. Kuntze. "Buffalo grass" is established on the east side of Penguin in the vicinity of the settlement.
- Spinifex longifolius* R. Br. Coarse perennial grass, dominant above the eastern beaches of Penguin and Seal.
- Spinifex hirsutus* Labill. Coarse perennial grass, above beach at Penguin (rare).
- \**Ehrharta longiflora* Sm. Annual grass. Penguin.
- Stipa variabilis* Hughes. Perennial tussock-grass. Penguin (dunes).
- Sporobolus virginicus* (L.) Kunth. Rare couch-like perennial grass growing near top of sea-sprayed cliffs, Penguin, Seal.
- \**Avena fatua* L. "Wild oats." Penguin.
- Poa caespitosa* Forst. Perennial tussock-grass. Penguin (dunes).
- \**Poa annua* L. Annual grass. Penguin, Seal, Bird.
- \**Vulpia myuros* (L.) Gmel. Annual grass. Penguin.
- \**Bromus gussonii* Parl. Annual grass. Penguin, Middle Shag, Seal.
- Bromus arenarius* Labill. Annual grass. Penguin, Middle Shag, Seal, Bird.
- \**Brachypodium distachyon* (L.) Roem. and S. Annual grass. Penguin.
- \**Lolium rigidum* Gaud. "Wimmera rye-grass." Penguin, Seal, Bird.
- \**Parapholis incurva* (L.) Hubb. Annual grass. Penguin.
- \**Hordeum leporinum*. Link. "Barley-grass." Common in gull rookeries: Middle Shag, Seal, Bird.

##### CYPERACEAE

- Scirpus nodosus* Rottb. Tall perennial sedge. Penguin.
- Scirpus antarcticus* L. Small annual sedge. Penguin (common in dunes).
- Lepidosperma gladiatum* Labill. "Sword-rush." Penguin (common above beach).

##### LILIACEAE

- \**Anthericum divaricatum* Jacq. Perennial herb. Above beaches: Penguin, Seal.
- Acanthocarpus preissii* Lehm. Sclerophyllous, subfruticose perennial. Penguin (dunes), Seal (2 plants only).

##### AMARYLLIDACEAE

- Conostylis candicans* Endl. Perennial herb. Penguin (windward slope of dunes).

## URTICACEAE

*Parietaria debilis* G. Forst. Annual herb. Penguin, Middle Shag, Seal, Bird.

## POLYGONACEAE

*Muehlenbeckia addressa* (Labill.) Meisn. Perennial twiner. Penguin (above beach and on dunes).

## CHENOPODIACEAE

*Rhagodia baccata* (Labill.) Moq. Succulent shrub. Penguin, Middle Shag, Seal, Bird.

\**Chenopodium murale* L. Annual herb. Middle Shag (common on northern talus slope). Bird (rare).

*Atriplex cinerea* Poir. Succulent shrub. Seal (above beach).

*Salsola kali* L. Annual herb. Above beaches: Penguin, Seal.

*Enchylaena tomentosa* R. Br. Spreading succulent shrub, common on talus slopes. Penguin, Middle Shag, Seal, Bird.

*Threlkeldia diffusa* R. Br. Ascending succulent perennial. All islands except Gull (common on rock and talus).

*Salicornia australis* Banks and Sol. Ascending succulent perennial. Penguin (top of northwestern cliffs).

## AIZOACEAE

*Carpobrotus aequilaterus* (Haw.) N.E.Br. Succulent perennial. All islands (common).

\**Carpobrotus edulis* (L.) N.E.Br. Succulent perennial. established in the settlement, Penguin.

*Tetragonia implexicoma* (Miq.) Hook. f. Succulent perennial, common on talus. Penguin, Middle Shag, Seal.

*Tetragonia zeyheri* Fenzl. Succulent perennial, common above beaches. Penguin, Middle Shag (rare), Seal, Bird (northern slopes).

## PORTULACACEAE

*Calandrinia calyptata* Hook. f. Prostrate succulent annual, common on talus. Penguin, Middle and West Shag, Seal, Bird.

## CARYOPHYLLACEAE

\**Cerastium viscosum* L., \**Stellaria media* (L.) Vill., \**Spergularia rubra* (L.) J. and C. Presl., \**Polycarpon tetraphyllum* Loef. Small annual herbs in dunes. Penguin.

## RANUNCULACEAE

*Clematis microphylla* DC. Woody climber in *Acacia rostellifera* scrub, Penguin.

## LAURACEAE

*Cassytha racemosa* Nees. Perennial climber, on *Acacia rostellifera*, Penguin.

## CRUCIFERAE

\**Sisymbrium orientale* L. Annual herb. Penguin, Middle Shag, Seal, Bird.

*Lepidium foliosum* Desv. Annual or short-lived perennial herb, common in gull rookeries. Middle Shag, Seal, Bird.

*Cakile maritima* Scop. Annual herb. Above beaches: Penguin and Seal.

*Hymenolobus procumbens* (L.) Nuttall. Small annual herb. Talus: Seal.

## CRASSULACEAE

*Crassula colorata* (Nees) Ostenf. Small annual herb. Penguin (dunes), Seal and Bird (sandy talus).

*Crassula pedicellosa* (F.v.M.) Ostenf. Small annual herb. Penguin (*Acacia rostellifera* scrub).

## PITTOSPORACEAE

*Pittosporum phylliræoides* DC. Shrub. Penguin (rare), Seal (dense thicket).

## LEGUMINOSAE

*Acacia cyclopis* A. Cunn. Shrub. Penguin (a single clump in open *Spyridium-Alyxia*).

*Acacia rostellifera* Benth. Tall shrub. Penguin (forms dense scrub on leeward slope of sand-dunes), Bird (northern slopes).

\**Melilotus indica* (L.) All. Annual herb. Penguin, Middle Shag, Seal, Bird.

\**Medicago denticulata* Willd. Annual herb. Penguin, Seal, Bird.

GERANIACEAE

\**Erodium cicutarium* (L.) L'Her. Annual herb. Gull rookeries: Middle Shag, Seal, Bird.

OXALIDACEAE

*Oxalis corniculata* L. Small annual herb. Penguin (shallow soil over limestone, rare).

ZYGOPHYLLACEAE

*Nitraria schoberi* L. Spreading succulent shrub, common on rock and talus, all islands.

*Zygophyllum billardieri* DC. Succulent scrambling herb. Seal (in sand among Rhagodia), Bird (sandy eastern top of western sector).

RHAMNACEAE

*Spyridium globulosum* (Labill.) Benth. Shrub. Penguin (windward slope of dunes).

MALVACEAE

\**Lavatera arborea* L. Tall perennial herb. Bird (a few with *L. plebeia*, western sector).

*Lavatera plebeia* Sims. Tall perennial herb. Gull rookeries: East, Middle and West Shag, Seal, Bird.

\**Malva parviflora* L. Annual herb. Gull rookeries: Middle Shag, Seal, Bird.

FRANKENIACEAE

*Frankenia pauciflora* DC. Small ericoid shrub. Shallow soil over limestone, especially above western cliffs: Penguin, Seal.

UMBELLIFERAE

*Apium australe* Pet.-Thou. Annual herb. Talus: Penguin, Middle Shag, Seal, Bird.

PRIMULACEAE

\**Anagallis femina* Mill. Annual herb. Penguin (dunes).

APOCYNACEAE

*Alyxia buxifolia* R.Br. Shrub. Penguin (windward face of dunes).

CONVOLVULACEAE

*Dichondra repens* R. and G. Forst. Small, stoloniferous herb. Penguin (shallow sand over limestone).

*Wilsonia backhousei* Hook. Small, ascending, shrublet. Penguin (a single colony in a sea-sprayed depression near top of northwestern cliffs).

SOLANACEAE

\**Solanum nigrum* L. Herb. Penguin, Middle Shag, Seal, Bird.

*Anthocercis littorea* Labill. Short-lived, mesophyllous shrub. Penguin (2 plants at eastern foot of dunes).

SCROPHULARIACEAE

\**Dischisma arenarium* E. Mey. Annual herb. Penguin.

MYOPORACEAE

*Myoporum insulare* R. Br. Woody shrub with semi-succulent leaves. Penguin, Middle Shag, Seal, Bird.

GOODENIACEAE

*Scaevola crassifolia* Labill. Low, spreading shrub with semi-succulent leaves. Penguin (a few plants above southwestern cliffs).

COMPOSITAE

\**Erigeron canadensis* L. Annual herb. Penguin.

*Olearia axillaris* (DC.) F.v.M. Shrub. Penguin (dunes), Seal (above beach), Bird (a few plants near top).

*Senecio laetus* Soland. Herb. Sandy talus: Penguin, Middle and West Shag, Seal, Bird.

\**Arctotheca nivea* (L.) Hoffm. Annual herb. Seal (a few on beach).

\**Arctotheca calendula* (L.) Levyns. Annual herb. Penguin, Seal, Bird.

*Helichrysum cordatum* DC. Perennial herb. Penguin (a few plants above beach).

*Angianthus cunninghamii* (DC.) Benth. Shrub. Penguin (a few plants in southwestern dunes).

\**Carduus tenuiflorus* Curtls. Annual herb. Penguin (on sand in sheltered situations).

\**Hypochoeris radicata* L. Annual herb. Penguin.

\**Sonchus oleraceus* L. Annual herb. Penguin, Middle Shag, Seal, Bird.

TABLE 2.—CATEGORIES OF PLANTS ON EACH ISLAND

	Penguin	Seal	Bird	Middle Shag	West Shag	East Shag	Gull
Sclerophytes	22	7	3	1	0	0	0
Mesophytes	4	2	2	2	1	1	0
Succulents	8	9	7	7	3	3	2
Annuals	11	9	6	5	2	0	0
Total Indigenous	45	27	18	15	6	4	2
Exotics	27	14	13	9	0	0	0
Total Flora	72	41	31	24	6	4	2

### DISCUSSION

When the number of indigenous species per island is plotted against the logarithm of its area, as in Fig. 2, the relationship is seen to be linear, which indicates a generally even rate of plant extinction with diminishing area.

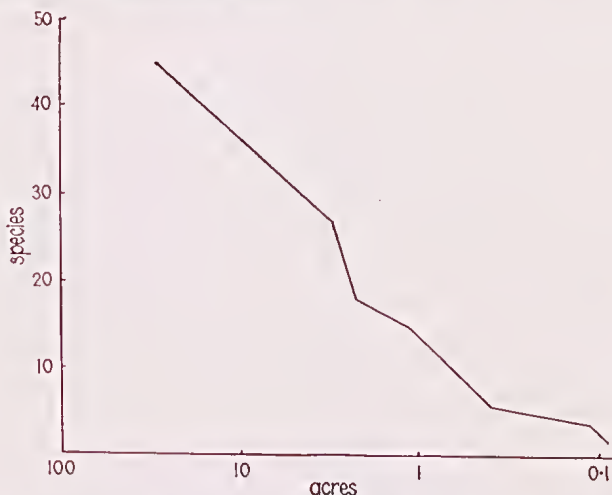


Fig. 2.—Number of plant species graphed against area of island (the scale of the latter is logarithmic).

The gradient is steepest between Seal and Bird, i.e. when area (aggravated by unfavourable orientation) becomes too small for the maintenance of dunes and beaches. These latter are the principal niches respectively for sclerophyllous shrubs and grasses (with sedges); consequently floristic disparity between Seal and Bird Islands is greatest in number of sclerophytes.

On the other hand the effect of diminishing area on number of succulent species is not nearly so marked; indeed Seal Island has

9 species against 8 on Penguin, which is ten times as large. The extinction rate for other plant categories lies between these extremes, the result of which is a steady change in composition of the flora, as well as its general impoverishment, as the islands diminish in area. For example, on Penguin Island sclerophytes comprise nearly half the indigenous flora; on Seal, Bird and Middle Shag their proportion is respectively 26, 17 and 7%.

Opportunity for exotic species to establish themselves likewise declines as the islands (and their number of niches) become smaller.

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### FROM FIELD AND STUDY

**Children's Python Preying on Free-tailed Bat.**—On June 26, 1960, in a cave on Mt. Anderson, 70 miles south-east of Derby, I noticed a Children's Python (*Liasis childreni*) crawling along a rock ledge 20 ft. above the floor. Almost as soon as I saw the snake it struck at a Free-tailed Bat (*Taphazous georgianus*), secured a grip and coiled about it. The bat soon weakened and fell. The two creatures landed at my feet and when I picked them up the bat was dead. I carried them back to our camp a mile away and the snake did not release its hold until it was placed in a collecting bag. The snake measured 18 in. in length.

—PETER SLATER, Derby.

**White Ibis in the South-West.**—The White Ibis (*Thveskiornis aethiopia*) has made its appearance once more in the Murray District. In the irruption of 1952, when there was a large influx of the Straw-necked Ibis into this area, White Ibis were seen. This year beside the usual 30-50 resident Straw-necked Ibis there has been an influx of ibis presumably from the north but not so many as in 1952. In July 1961 Colin Paterson saw a White Ibis among 20-30 birds two miles north of Pinjarra. On August 9 Fred Grantham saw a White Ibis with black head and black tip to wing in a flock of 20-30 birds two miles west of Coolup. I have not heard of any other species which was noted in the southern irruption of 1952 (*W.A. Nat.*, 3: 177-196) having been seen this year.

—ANGUS ROBINSON, Coolup.

**Pheasants Feeding on Snails at Rottnest I.**—On October 9, 1960 a hen Pheasant (*Phasianus colchicus*), a species introduced on Rottnest Island, struck a power line after a high speed take off and dropped dead. The crop seemed unduly swollen and hard. On examination I found it to be crammed with snails (*Theba pisana*).